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Model of nonadiabatic-to-adiabatic dynamical quantum phase transition in photoexcited systems

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Abstract

© 2014 American Physical Society. We study the ultrafast dynamic process in photoexcited systems and find that the Franck-Condon or Landau-Zener tunneling between the photoexcited state and the ground state is abruptly blocked with increasing the state coupling from nonadiabatic to adiabatic limits. The blockage of the tunneling inhibits the photoexcited state from decaying into the thermalized state and results in an emergence of a metastable state, which represents an entanglement of electronic states with different electron-phonon coupling strengths. Applying this model to the investigation of photoexcited half-doped manganites, we show that the quantum critical transition is responsible for more than a three-order--f-magnitude difference in the ground-state recovery times following photoirradiation. This model also explains some elusive experimental results, such as photoinduced rearrangement of orbital order by the structural rather than electronic process and the structural bottleneck of a one-quarter period of the Jahn-Teller mode. We demonstrate that in the spin-boson model there exist unexplored regions not covered in the conventional phase diagram.

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